

## 2. Removal of Vegetation

Vegetation removal typically reduces water loss from the soil by transpiration. More precipitation falls on the soil as less is intercepted by vegetation. The increase in surface water depends on the amount of water available, soil depth and the percentage of drainage area harvested.

## 3. Accelerated Snowmelt

Snowmelt is a major contributor of surface water in all hydrologic regions, except in lowland parts of the Puget Sound area. Harvesting can redistribute the snowpack and increase solar radiation, which in turn can affect snowmelt rates and thus the seasonal timing of surface water movement. The effects of these changes vary with the extent and type of harvesting and with topography. Greater accumulation of snow can occur in openings caused by clearcuts or even partial cuts than under the closed forest canopy.

If openings are large or not shaded by vegetation, the snowmelt season is usually shortened. If there is no significant increase in solar radiation incident on the snowpack, the snowmelt season can actually be lengthened. It is also possible that the increased melt rate and accumulation are in such a proportion to the forested area as to cause no change in the snowmelt season.

## 4. Changes in Temperature

Surface water temperature can also be affected by timber harvesting. Removal of vegetation beside small streams and water bodies may increase solar radiation, thus raising temperatures. Temperature increase is a function of the volume of water exposed, flow velocities, amount of incident radiation and type of stream bottom. Increased temperature lowers oxygen solubility in surface water to further degrade water quality.

## 5. Increased Sedimentation

Soil disturbance that occurs from timber harvesting may contribute to increased sedimentation of surface water. Removal of timber can expose mineral soil to more raindrops, which then detach soil particles. Duff removal, compaction and channel formation also encourage erosion and sedimentation in surface water. Timber harvesting and related activities can also increase the potential for mass wasting.

## 6. Herbicides

Herbicides can affect surface water quality. The degree of impact depends on the herbicide used and the means by which it reaches water. Herbicides may reach surface water from direct application, runoff and leaching. Direct application (or drift) to surface water will produce the most serious concentration levels. Herbicide contamination from runoff, however, is limited because herbicides normally degrade after reaching the forest floor.

In general, there must be heavy precipitation soon after application for herbicides to reach surface water. Herbicide leaching from soil and subsequent movement by subsurface flow to surface water is also limited because the herbicide is normally absorbed by the soil. Little is available for leaching. The accidental application of herbicides to surface water is very unusual.

## 7. Insecticides

The department's use of insecticides, though rare, may degrade surface water quality. Some insecticides persist in the environment. The faster a chemical degrades, the less chance it has to reach surface water. There is a wide variation in the degradation rate of insecticides. Selection of insect and disease control measures will comply with the State Environmental Policy Act (SEPA). The department will prepare an environmental checklist and, if necessary, an EIS before using insecticides on state forest land.

## 8. Fertilizers

The department is reducing the use of fertilizers, which in turn should decrease any adverse impacts to surface water quality.

Use of urea as fertilizer can impact surface water quality in two ways. The first impact involves the toxicity that results from nitrification, a process that changes ammonia to nitrite and then to nitrate. The second is the acceleration of eutrophication from increased nutrient levels and subsequent growth of water plants. To examine the impacts of fertilization on these properties, the department cooperated in several monitoring studies. Results showed that less than 1 percent of the fertilizer applied reached surface waters from small feeder streams that were not protected by buffers. Peak concentrations never reached toxic levels; background levels were re-established within four months. Some fertilizer may also reach streams by runoff if it rains shortly after fertilization. For the most part, however, direct applications to surface water cause the most significant impacts.

## 9. Wildlife and fish habitat

Wildlife and fish that depend on surface water may be affected by timber harvesting. Removal of vegetation beside water bodies may increase solar radiation and raise temperatures. This impact applies chiefly to Type 5 Waters (streams that dry up for a portion of the year) because the department routinely prepares riparian management zones for other classifications.

### 8.3.3.2 Ground Water

Removal of vegetation by timber harvesting may affect the supply and quality of ground water. In some cases where tractor logging has compacted soils, ground water quantity can actually decrease. (Severely-compacted soils lose their ability to absorb water, and the precipitation no longer percolates into the ground.)

Another effect on ground water can occur if timber harvesting reduces nutrient uptake and increases the decomposition rate of organic matter on and near the soil surface. In that situation, soil nutrients can leach into ground water.

Finally, if road construction or other activity seriously disrupts subsurface water flow, the water may reach the ground and become runoff, adding to erosion.

### 8.3.3.3 Runoff, Floods and Absorption

Runoff and absorption rates are closely related to soil type and harvesting activity. On fine-textured soils, compaction from timber harvest is a greater problem than on coarse-textured ones. When fine-textured soils are compacted, their structure is destroyed and most of their porosity is lost, thus increasing chance of runoff. Medium-textured soils, such as loams, are most susceptible to problems caused by logging and road construction.

Logging can also result in reduced soil moisture depletion and accelerated recharge. Removing ground cover and duff also exposes soil to more frequent impacts from heavy rains, an important factor in detaching soil particles. Detachment decreases soil infiltration and increases the chances of damage from runoff. If runoff results from harvest disturbance, skid trails become channels, concentrating and conveying the flow of water.

Partial cutting, which requires more tractor logging, usually disturbs and compacts soil more than cable systems, thus increasing the chances for runoff.

Local flooding can be caused by excess debris from timber harvesting, site preparation or precommercial thinning that enter stream channels. When debris becomes temporarily stabilized or accumulates at stream crossings, water can back up and rise above the high-water mark. If debris jams suddenly give way, the backwater surges downstream, flooding the area.

#### 8.3.3.4 Public Water Supplies

Timber harvesting can decrease the usable amount of public water supplies if too much sediment is produced. Although dissolved solids increase because of clearcut harvesting, concentrations seldom exceed drinking water quality standards.

Road construction can also impact public water supplies by increasing erosion, which in turn can create turbid conditions in water and, if present in large quantities, by reducing reservoir capacities with deposition over time. Extensive precommercial thinning may have an affect on public water supplies if a large percent of the basin area has timber removed.

#### 8.3.3.5 Mitigation Measures (Water)

The department has identified the following specific mitigation measures to protect water quality and quantity:

##### 1. Surface Water and Riparian Areas

The effect of timber harvesting on surface water quantity and quality can be controlled by following proper procedures, many of which are contained in the Forest Practices Act regulations. The regulations will likely mitigate the adverse impact of harvest.

Riparian areas are important for fish habitat, water quality and other nontimber resources. The preferred policy ( Policy 20) requires the department to establish protective riparian management zones, where activity is limited or where the department intends to modify its actions to protect fish and wildlife habitat and other key nontimber resources. Some strips of timber, for instance, are left along streams that are sensitive to temperature. Protecting water temperature in these situations may be important for fish habitat; the strips provide shade to prevent unacceptable increases in stream temperature and potential loss of fish habitat. Establishing these zones will help reduce the impact from timber harvesting. The preferred policy exceeds existing Forest Practices Act regulations and thus offers an additional mitigation measure. Care is taken to buffer the vegetation in riparian management zones from pesticides and herbicides.

The department has taken steps to ensure that its herbicide program will not affect surface water. In May 1986, the department commissioned a report, "Worst Case Analysis Study on Forest Plantation Herbicide Use," prepared by K.S. Crump and Co., Inc. The report evaluates the entire range of impacts of specific herbicides on the forest environment, including but not limited to water, flora, fauna and human health. In 1987, as a response to the worst case analysis, the department prepared a document, "Herbicide Use on State Forest Lands Public Response Summary and Proposed Management Approach." In addition, the department relies on another report, "Biological and Physical Effects of Forest Vegetation Management," dated September 1984, by Newton and Dost, in its evaluation of herbicides. All three documents are incorporated by reference into this chapter.

The department intends to maintain surface water quality by using the least amount of fertilizer and herbicides needed to achieve optimum tree growth. Genetically-superior trees could reduce the need for fertilizers.

Washington law prohibits application of aerial herbicides within buffer zones along all but the smallest class of streams. This measure provides protection of riparian vegetation and minimizes entry of herbicides into streams. Violations of these rules are infrequent, and it is extremely doubtful that such violations have been of a nature having measurable biological effect on aquatic organisms or water users.

## 2. Runoff, Floods and Absorption

To mitigate impacts of timber harvesting on runoff and absorption, the department's selection criteria for logging systems include a requirement for minimal soil disturbance. Tractor logging, for instance, will be restricted to areas where slopes are less than 30 percent and soil conditions are not sensitive to disturbance and compaction. The Forest Practice regulations require that skid trails be kept as narrow as feasible. Yarding will be used with cable systems, whenever possible. During downhill yarding, reasonable care is required to lift the leading ends of logs to minimize disturbance.

Flooding and runoff can be decreased and absorption increased by reducing initial compaction. Surface water quality will also improve as erosion is reduced and absorption increases. Shade reduction caused by site preparation, conversion, thinning and vegetation control will be mitigated by leaving strips along streams.

### 3. Ground Water

In most cases, department activities that affect ground water (such as aquifers) are minimal. Nonetheless, the department attempts to decrease potential negative affects on ground water in road design, selection of harvest location and other practices. The department's efforts to replant trees as soon as possible after harvest will also help mitigate adverse impacts. Establishing a new stand of trees will help maintain the hydrologic balance.

### 4. Public Water Supplies

The quantity and quality of public water supplies are a concern to the department, which has adopted a watershed policy (see Policy No. 19) that requires it to conduct a risk analysis of its activities in watersheds and, where appropriate, to assess the cumulative impacts of its activities.

Public water purveyors will be informed of any activity that will significantly affect the quality or quantity of water they receive from state forest lands. They will be informed of fertilization and pesticide applications and other major silviculture activities in the department-managed portion of the watershed. Agreements may be negotiated when needed for projects in municipal watersheds.

### 5. Wildfire Prevention Efforts

The department's program to minimize wildfires may minimize the detrimental effects of wildfires on soil and water quality. Wildfires can accelerate sedimentation and increase dissolved solids when runoff is produced from burned areas. Nutrients released by fire can enter surface water and increase dissolved solids.

The department's fire protection policy (Policy No. 10), which directs the department to supplement its fire protection efforts, will provide additional mitigation to water resources on state forest land.

#### 8.3.3.6 Unavoidable Adverse Impacts (Water)

There are several unavoidable, adverse impacts from timber harvesting and road construction on water quantity and quality.

##### 1. Accumulation of Debris

Despite strict controls, there is always a chance that debris will enter stream channels. This is a natural process that occurs even without man's influence but is likely to occur more frequently in areas of road building, logging and other activities. Debris from site preparation activities, such as slashing or cutting vegetation, can also alter surface water movement if it is felled into streams. As a general rule, water quantity and quality are not affected by precommercial thinning, though this activity can also create debris that enter stream channels.

##### 2. Road construction and Public Access

The construction of some roads and rights of way will likely have some impact on surface water quantity and quality, no matter how stringently state standards are enforced by the department.

Public access can have a significant impact on surface water, particularly water movement and quality. Most impacts result from stream crossing structures. During construction of crossing structures, channel flows may be diverted. Off-the-road vehicles tracks can also channel water to other drainage areas.

Although many mitigation measure are taken in road construction and maintenance, some added sediment in surface waters will continue to occur as a result of department roads. Most of this sediment will come from runoff. In some extreme cases, when storms exceed the road design, quantities of sediment may also affect surface water. Since 1977, however, the department has designed roads for 100-year storms. By building and maintaining roads according to Forest Practices Act specifications, the department believes it will avoid serious damage from sediments during severe storms or other catastrophic events.

##### 3. Wildfires

Wildfire usually affect large areas. A hot fire on some soils may result in lower absorption rates and increased runoff from burned slopes. The greater the area burned, the greater the impact. The wildfire control program, by reducing acres burned, limits this impact. The department's program, no matter how effective, cannot eliminate wildfires, and some impact on water quality is therefore likely to occur.

In addition, fire suppression activities themselves may decrease or divert water movement. Small dams are sometimes constructed to provide ponds for filling tank trucks and helicopters. Water backs up behind the dams and flow velocities are decreased for short periods. Construction of fire trails, either during fire suppression or prevention, clears vegetation down to mineral soil. These activities, though of short duration and impact, can reduce absorption and increase runoff, especially on steep slopes. Wildfire can also affect flooding on forest drainages.

#### **8.3.4 Land Use**

The department has no direct control over local land-use classifications and plans, but its sizeable land base affects the character and economy of many communities around the state. The department intends to continue working with counties and other local governments on areas of mutual concern.

There are three different types of state forest lands: Federal Grant, Forest Board and Community College Forest Reserve. In total, these lands contain 2.1 million acres. Specific land use impacts are identified below.

##### **8.3.4.1 Federal Grant Land Base**

Approximately 1.463 million acres of forested Federal Grant lands are addressed by the plan. The department's policy on maintaining the diversity of the Federal Grant land base (Policy No. 1) allows it to consider economic returns and other factors in deciding when and where to sell, buy or exchange Federal Grant lands. The department is not required to maintain Federal Grant lands in forest production in perpetuity. The department will evaluate the economic and environmental impact of each transaction at the time it is proposed.

##### **8.3.4.2 Forest Board Land Base**

There are approximately 607,000 acres of Forest Board lands in Washington. Unlike Federal Grant lands, state law requires that Forest Board lands be kept in perpetual forest production. Because many of these lands are near developing areas in the Puget Sound area, the department intends to work with local governments, particularly in areas that are experiencing rapid growth.



#### 8.3.4.3 Community College Forest Reserve

Approximately 3,223 acres of Community College Forest Reserve lands, the smallest category in state forest lands, are addressed by the plan. These properties provide a buffer between working forest and urban and suburban uses. They are managed for a variety of purposes, including timber production, aesthetics, watershed protection and wildlife habitat.

#### 8.3.4.4 Mitigation (Land Use)

Timber harvest on certain state forest lands, particularly those near urban or suburban populations, may have indirect, adverse impacts on land-use patterns in the area. The department will attempt to assess these impacts at the time it sets landscape level objectives and/or considers a specific timber sale.

Where appropriate, the department will attempt to mitigate the impacts of these activities. The department is committed to working with local governments and neighboring landowners on issues of common concern, and it intends to resolve many of these problems during its planning process.

#### 8.3.4.5 Unavoidable Adverse Impacts (Land Use)

Because the department has a responsibility to produce income for the trusts, there may be situations where the department will harvest areas near urban or suburban areas that will indirectly affect land use (such as recreational opportunities or aesthetics).

### 8.3.5 **Natural Resources**

#### 8.3.5.1 Rate of Use and Nonrenewable Resources

The rate of use of natural resources (such as quarry rock) in various timber harvest alternatives depends essentially on road requirements. In the past, the department has consumed as much as one million cubic yards of quarry rock and gravel in a year. Amounts are expected to be reduced by as much as 25 percent or more during the next decade. Reductions in major road system development are anticipated as timber harvest activities are reduced or alternate logging systems are employed.

The Forest Resource Plan will not affect the rate of use of nonrenewable resources such as coal, oil, gas and other minerals. The department's Land and Minerals Division administers these leases, which are not within the scope of this plan.

In addition, the department uses petroleum for its own fleet of vehicles. Until alternative fuels are readily available and cost effective, the department will continue to rely on petroleum fuels.

#### 8.3.5.2 Rate of Use and Renewable Resources

Timber is a renewable resource, and the rates of harvest and use are discussed elsewhere in this plan. In the 1980s, the department harvested approximately 30,000 acres of timber each year (equivalent to about 756 million board feet). Although the department has not established a harvest level for the 1990s, it expects the amount of timber harvested to be less than in the 1980s.

Policy No. 4 describes the department's sustained, even-flow policy. Other harvest and silvicultural policies describe the methods and practices the department will use to produce timber from state forest land in the 1990s.

Table 22 at page 99 shows the projected silvicultural practices the department is expected to employ in the 1990s. Table 23 at page 100 shows the range of silvicultural practices used in the 1980s.

#### 8.3.5.3 Mitigation Measures (Natural resources)

The Forest Practices Act requires the department (and other landowners) to reforest land that has been logged. The department believes this requirement mitigates some of the potential adverse environmental impacts of harvesting and ensures that timber remains a renewable resource. As trustee, the department has an interest in keeping state forest lands productive.

The department's road system policy (See discussion in Forest Resource Plan for Policy No. 28) calls for a reduction in the amount of department-built and maintained roads through coordination and cooperation with adjacent land owners. As a result, the rate of use (amount of material used) for building and maintaining roads will likely decrease in the 1990s from what it was in last decade.

Through careful planning prior to timber sales, the department minimizes the amount of new roads that need to be built. It attempts to work with adjacent landowners to plan for an efficient road system. Care is also taken to build the appropriate size of road for the particular purpose or goal. By following these procedures, the department attempts to minimize its internal costs of building and maintaining roads.